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Intention of preserving forest remnants among landowners in the Atlantic Forest: The role of the ecological context via ecosystem services

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Abstract

1. Unravelling the psychological processes determining landowners' support towards forest conservation is crucial, particularly in rural areas of the tropics, where most forest remnants are within private lands. As human–nature connections are known to shape pro-environmental behaviours, the intention of preserving forest remnants should ultimately be determined by the ecological context people live in.
2. Here, we investigate the pathways through which the ecological context (forest cover), via direct contact with forests and ecosystem services and disservices, influence the psychological antecedents of conservation behaviour (beliefs, attitude and intention of preserving forest remnants). We conceptualized a model based on the Reasoned Action Approach, using the ecological context and these three forest experiences as background factors, and tested the model using Piecewise Structural Equation Modelling. Data were collected through an interview-based protocol applied to 106 landowners across 13 landscapes varying in forest cover in a consolidated rural region in the Brazilian Atlantic Forest.
3. Our results indicate that: (a) ecosystem services are more important than disservices for shaping intention of preserving forests, particularly non-provisioning services; (b) contact with forest has an indirect effect on intention, by positively influencing the frequency of receiving ecosystem services; (c) people living in more forested ecological contexts have more contact with forests, receive ecosystem services more frequently and, ultimately, have stronger intention of preserving forests.
4. Hence, our study suggests a dangerous positive feedback loop between deforestation, the extinction of forest experiences and impairment of human–nature connections. Local demands across the full range of ecosystem services, the balance

between services and disservices and the ecological context people live in should be considered when developing conservation initiatives in tropical rural areas.

KEYWORDS
benefits from nature, environmental psychology, extinction of experience, socioecological systems, theory of planned behaviour, tropical forest

1 | INTRODUCTION

Over the last decades, the framing of conservation science has changed, reflecting mainly the way human–nature relationships are viewed. Conservation thinking shifted from focusing on species to targeting the integrated management of ecosystems, and from an emphasis on an one-way relationship of nature for people to recognizing the dynamic, two-way relationships between people and nature (Mace, 2014). Simultaneously, there has been a growing recognition that conservation is a social phenomenon, as conservation initiatives depend upon our choices and behaviour (Mascia et al., 2003). Hence, integrating natural and social sciences has been considered crucial not only to advance our knowledge on the feedbacks between ecosystems and society (Milner-Gulland, 2012), but also for achieving more legitimate, salient, robust and effective conservation (Bennett et al., 2017). Across the disciplines within the social sciences, psychology has been considered particularly relevant to conservation, by providing human decision-making frameworks that allows not only to understand and predict human behaviours, but also to develop strategies to promote behavioural changes (St John, Edwards-Jones, & Jones, 2010; St John, Keane, & Milner-Gulland, 2013).

Using psychological frameworks to understand the relationships between people and ecosystems is of utmost importance in the tropics (Rueda, Velez, Moros, & Rodriguez, 2019), given the significance of these regions in terms of both conservation and poverty alleviation (Barrett, Travis, & Dasgupta, 2011; Fisher & Christopher, 2007). In addition, because a considerable part of remaining tropical forests are outside the protected areas (e.g. Rezende et al., 2018), the scattered forest remnants across rural areas of the tropics are essential for both biodiversity conservation (e.g. Banks-Leite et al., 2014) and ecosystem service provision, not only locally (e.g. pest control; Librán-Embid, De Coster, & Metzger, 2017), but also globally (e.g. climate regulation; Canadell & Raupach, 2008). However, despite the relevance of community-based conservation in indigenous or traditional territories (Garnett et al., 2018), communities, in the strict sense (Agrawal & Redford, 2009), are not the rule everywhere. In certain consolidated rural areas of the tropics, forests are not under common-property regimes, that is, forest resources are not used nor held by several individuals or families, and management is not shared in groups (McKean, 2000; Ostrom, 1990). Instead, well-delimited private properties owned by families or agricultural companies are prevalent. Top–down government institutions regulating the conservation of tropical forest in these private areas may exist, but compliance is usually low (e.g. Rezende et al., 2018). Hence, untangling the drivers of landowners' intention of preserving forest remnants in these consolidated areas is critical to identifying ways to foster their support to conservation (e.g. de Snoo et al., 2013) as well as their engagement in environmental governance arrangements (Armitage, Loë, & Plummer, 2012).

In this regard, a growing body of evidence suggests that a key driver of pro-environmental behaviour and support towards conservation are nature experiences, which in turn, strongly depend on the environmental or ecological context people live in. However, this evidence comes from distinct, disconnected disciplines, focusing on different perspectives and approaches, and using a multitude of terms sometimes with different meanings (Ives et al., 2017; Muhar et al., 2018). Nature experiences, then, have been used to denote either the contact with natural settings (e.g. frequency and duration of visits; Shanahan et al., 2017), specific nature-based activities (e.g. picking plants and hiking; Wells & Lekies, 2006), or experiences of nature, which also encompass changes as to how people feel (Clayton et al., 2017).

Within this varied literature, many studies have shown that nature experiences increase conservation support. Most of them were carried out in urban areas of developed countries (but see Rosa & Collado, 2019), and measured experiences mainly as frequency of visits to greenspaces and/or nature-based activities (e.g. Dean, Barnett, Wilson, & Turrell, 2019; Sato, Ushimaru, & Minamoto, 2017; Wells & Lekies, 2006). Although a variety of behavioural aspects have been addressed – including tolerance (e.g. towards problem-causing wildlife; Hosaka, Sugimoto, & Numata, 2017), willingness (e.g. to conserve animal biodiversity; Soga, Gaston, Yamaura, Kurisu, & Hanaki, 2016) and pro-environmental behaviours (e.g. contributing to conservation NGOs; Zaradic, Pergams, & Kareiva, 2009) – in general, available studies are not directly based on behavioural psychological frameworks. In addition, while a few studies with children compared urban and rural settings (e.g. Collado, Corraliza, Staats, & Ruiz, 2015; Zhang, Goodale, & Chen, 2014), we still know little about which are the relevant nature experiences to and how they affect conservation support – by people living within rural areas of the tropics.

Beyond the effects of nature experiences on conservation support, there is also consistent evidence that nature experiences depend upon the context people live in. For instance, compared to urban children, those living in rural settings visit more frequently, and spend more time in, natural places (Collado et al., 2015) and engage more frequently in nature-based activities (Zhang et al., 2014).

Similarly, in urban areas of developed countries, the amount of greenspace increases visitation frequency (Lin, Fuller, Bush, Gaston, & Shanahan, 2014) and duration (Shanahan et al., 2017; Soga et al., 2015). Furthermore, urban–rural context affects not only contact with nature or nature-based activities, but also how people perceive nature. For instance, the perception of the potential of ecosystems to provide services (Affek & Kowalska, 2017) or the valuation of ecosystem services (reviewed in Lapointe, Cumming, & Gurney, 2019) vary between rural and urban residents. However, not only these studies are concentrated in developed countries (Lapointe et al., 2019), but also they focus mainly on urban settings or urban–rural contrasts (but see Dorresteijn et al., 2017).

The links between the context people live in and nature experiences, and between nature experiences and pro-environmental behaviour and conservation support, have led to awareness about what some have called the extinction of experiences with nature (Pyle, 2003, 1993). Multiple studies have focused on the risk of the extinction of experiences driven by urbanization, and by the shift from outdoor to indoor leisure activities (e.g. Miller, 2005; Soga & Gaston, 2016). Others have argued that the extinction of experiences can lead to nature disconnection and devaluation that in turn would lead to a dangerous feedback loop on subsequent nature experiences (Pyle, 2003; Soga & Gaston, 2016). This has created concern for both conservation (e.g. Balmford & Cowling, 2006; Miller, 2005; Stokes, 2006) and public health (Soga & Gaston, 2016), as interacting with nature affects human physical health, cognitive performance and psychological well-being (Bratman, Hamilton, & Daily, 2012; Keniger, Gaston, Irvine, & Fuller, 2013). Yet, addressing this feedback loop between the extinction of nature experiences and conservation support requires studies encompassing all the pathways connecting the context where people live in with their intentions and behaviours via nature experiences. This type of study integrating human and ecological components is rare in the literature, particularly, considering the role of deforestation instead of urbanization, and focusing on rural areas of the tropics instead of urban areas of developed countries (but see Dorresteijn et al., 2017).

Here, we intend to contribute to filling the gaps concerning the relevance of deforestation to alter nature experiences, and the role of these experiences in shaping conservation support, in rural areas of the tropics. We do so by considering both contact with forests and experiences of forests – conceptualized as received ecosystem services and disservices, and by developing a model based on the Reasoned Action Approach from Social Psychology (RAA; Fishbein & Ajzen, 2010) (Figure 1). We focus on a consolidated rural region of the Brazilian Atlantic Forest, a threatened biodiversity hotspot (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000), where the long history of disturbance has drastically reduced forest cover (Joly, Metzger, & Tabarelli, 2014; Ribeiro, Metzger, Martensen, Ponzoni, & Hirota, 2009). Most forest remnants (70%) are within private lands, where a huge legal debit of over 5 million ha of riparian areas should be restored (Rezende et al., 2018). Specifically, we investigate the relevant pathways through which the ecological context – represented by the amount of remaining native forest in the landscape – influences landowners' beliefs, attitude and intention of preserving forest remnants within their properties, considering both the direct contact they have with forests (visits to the forest) and their experiences of forests (received ecosystem services and disservices; Figure 1).

2 | MATERIALS AND METHODS

2.1 | Conceptual model

Our conceptual model is based on the RAA (also known as Theory of Planned Behavior; Fishbein & Ajzen, 2010). RAA assumes background factors, such as previous experiences, influence the psychological determinants (e.g. beliefs, attitude, intention) of a given behaviour. Here, we propose that the ecological context people live in, together with the contact they have with forests and how they experience forests, can be conceptualized as background factors, affecting people's intention to preserve forest remnants within their properties (Figure 1).

As a proxy of the ecological context where people live, we quantified native forest cover surrounding participants' households (Figure 1). The amount of native forest not only is related to the proximity and size of forest ecosystems, but also determines the diversity

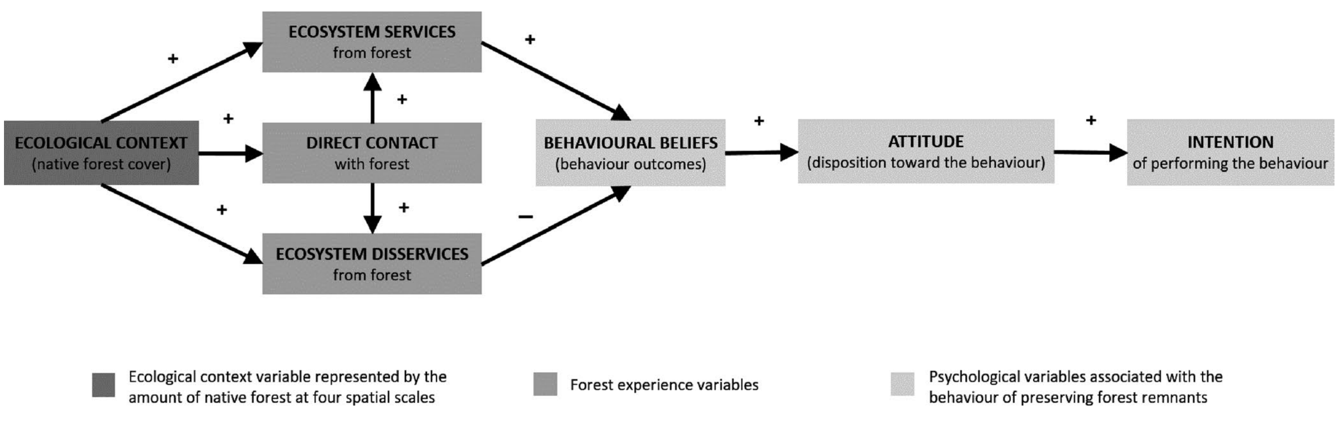

FIGURE 1 Representation of the conceptual model we tested using Piecewise Structural Equation Modelling, indicating the variables and pathways through which the ecological context people live in influences beliefs, attitude and intention of preserving forest remnants within private properties. Arrows – causal links between variables. +, – postulated positive and negative effects

and integrity of biological communities in the Atlantic Forest (Banks-Leite et al., 2014), and thus should affect the provision of ecosystem services and disservices (e.g. Librán-Embid et al., 2017). We expect that these aspects of forest ecosystem – proximity, size, integrity and functioning – influence the opportunities to have contact with and to experience forests (Figure 1). Specifically, we expect that forest cover increases: (a) direct contact people have with forest (visits to forest) by increasing proximity to forests, (b) frequency of receiving ecosystem services by increasing service provision and (c) frequency of receiving certain types of disservices, such as those caused by venomous animals or animals that attacks crops, poultry or livestock, by increasing species abundance.

In contrast to mere contact with nature, experience of nature refers to something that happens to a person that affects how he/she feels and can be either positive or negative (Clayton et al., 2017). Thus, the frequency of receiving ecosystem services and disservices are conceptualized as experiences of forest, which directly influence (positively and negatively, respectively) the beliefs on the outcomes of preserving forest (Figure 1). In contrast, direct contact with forest should affect beliefs indirectly, by increasing the chance of experiencing forest – that is, receiving ecosystem services and disservices (Figure 1). While contact with nature can be either direct (intentional or incidental) or indirect (i.e. observing nature at a distance; Keniger et al., 2013), we assume that indirect contact should be very common and widespread in rural areas, making direct contact with forest (visiting forests) the most relevant type of contact with forest in these settings.

The final part of the model concerns the pathways linking psychological constructs (Figure 1). In RAA (Fishbein & Ajzen, 2010), behavioural beliefs represent what people believe will happen (i.e. specific outcomes related to benefits or harms/disadvantages) when the behaviour is performed. They are the antecedents of personal attitude (i.e. how favourable a person is in relation to the behaviour). Lastly, attitude is one of the determinants of the intention of performing a given behaviour (i.e. the perceived subjective probability of performing that behaviour). RAA assumes that, along with attitude, subjective social norms and perceived behavioural control determine the intention of performing a behaviour. However, we did not consider these other antecedents of intention, as they are not supposed to be clearly linked to the ecological context people live in.

2.2 | Study area

Located along the Brazilian coastline, the Atlantic forest was the first region to be populated in Brazil, and today harbours less than 16% of its original forest cover, the largest cities in the country and over 70% of the Brazilian population (~125 million people; Joly et al., 2014; Ribeiro et al., 2009). Since the 16th century, sequential cycles of economic exploitation occurred in the region, beginning with the logging of the Pau-Brasil tree (*Caesalpinia echinata*), followed by exploitation of different commodities, and, more recently, by the expansion of cattle ranching and Eucalyptus plantations (Joly et al., 2014). As a result of this long history of disturbance, 70% of the remaining Atlantic Forest is immersed in human-modified landscapes of agro-mosaics within private lands (Rezende et al., 2018), making the conservation of these remnants essential. Across these consolidated rural areas, private properties are mainly family-based or agricultural business. Hence, forests can rarely be characterized as a common pool resource and are not managed under a common property regime.

With altitude ranging from 700 to 1,700 m and a humid subtropical climate, the 3000-km^2 study region is located nearby the São Paulo metropolitan area – the largest in Brazil (~21 million people), within the State of São Paulo (Figure 2a), which has the highest Gross Domestic Product (~11% of the national GDP) and the highest Human Development Index across the 26 Brazilian states. The study region was predominantly rural until the 70s, when the Cantareira water reservoir system – one of the largest in the world – was constructed, followed by the construction and duplication of two major highways. This led to the expansion of dispersed urban areas, associated mainly with second houses and tourism (Whately & Cunha, 2007).

Today, the study region encompasses densely populated (5.5 ± 4.9 households/km^2) rural areas, where nearly 50,000 people live (IBGE, 2011). The size of rural properties is heterogeneous, varying from >1 to 4,095 ha (mean ± *SD*: 28 ± 104 ha), and the main farming activities are dairy cattle raising and eucalyptus forestry. About 80% of the native forest and 74% of riparian areas under legal protection have been converted to pasture and silviculture (Vieira & Vieira, 2016). Dense montane Atlantic Forest remnants varying in size and regeneration stages are distributed mostly within private properties and are essential for biodiversity conservation, as they connect large tracks of Atlantic Forest in the Cantareira-Mantiqueira complex. Additionally, the remaining forest fragments are crucial for the Cantareira reservoir system, which supplies water for the São Paulo Metropolitan Area. As such, a number of conservation projects, including environmental education, forest restoration and payment for ecosystem services, are being carried out in the region.

2.3 | Sampling design

We adopted a three-step, hierarchical sampling design. We first selected landscapes that varied in the proportion of native forest, and then selected properties within landscapes and participants within households of these properties.

2.3.1 | Landscapes

We selected 13 landscapes of 3-km radius (2,830 ha) maximizing difference in native forest cover (10%–50%, Figure 2b,c), to ensure variation in the ecological context, but controlling for factors associated with agricultural potential. Landscapes were then restricted in relation to altitude (800–1,200 m), soil type (either ferric

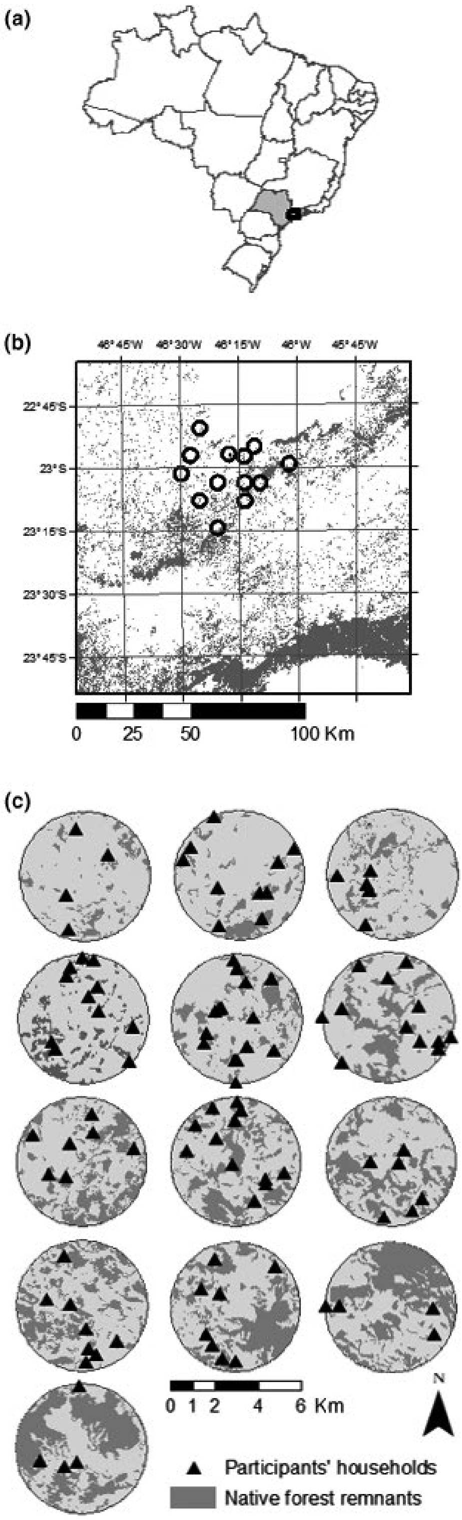

FIGURE 2 Study region, study landscapes and the location of participants' households. (a) São Paulo State in Brazil and the study region. (b) Atlantic Forest remnants and the study landscapes. (c) Location of participants' households within the study landscapes, ordered in ascending percentage of forest cover

red latosol or argisol) and land-use (cattle pastures and eucalyptus plantations). We also avoided major highways, water reservoirs and large urban areas.

2.3.2 | Properties

To select properties within landscapes, we used information from the Rural Environmental Registry (*Cadastro Ambiental Rural* – CAR), a georeferenced database of the property limits, mandatory for owners of properties destined to agriculture (INCRA, 2010). Using a forest cover map and the limits of properties from CAR, we calculated the amount of native forest in each property. We excluded properties that: had no houses or the main house was located outside the study landscape (checked with satellite images), overlapped more than one study landscape or encompassed less than 1 ha of the native forest (to restrict to properties harbouring forests of some conservation value). This procedure resulted in a set of 301 properties visited subsequently (Data S1).

2.3.3 | Participants

By visiting all 301 pre-selected properties, we checked if the landowner, self-declared as the responsible for deciding how to manage the property, inhabited the property (thus excluding temporary residents at second houses) and was of age; if so, he/she was invited to participate in the study (Data S1). Among the 301 properties, 129 landowners matched the criteria above, and 106 accepted to participate (Figure 2c; Data S1).

2.4 | Data collection

2.4.1 | Ecological context

We calculated native forest cover around participants' households considering four radii (0.5, 1.0, 1.5 and 2.0 km) using R 3.4.3 (R Core Team, 2017). Forest cover was mapped manually using a mosaic of high-resolution satellite images (SPOT and Digital Globe, scale of 1:5,000). We considered different radii to account for possible differences in the scale of effect of the ecological context on different types of forest experiences – for example, direct contact with forest may be associated with forest cover at smaller spatial scales than the frequency of receiving ecosystem services or disservices. The variation in forest cover was similar among the four radii, varying between 0%–58%, 4%–53%, 4%–57% and 5%–55% at 0.5, 1.0, 1.5 and 2.0 km radius respectively.

Using a structured protocol applied via face-to-face interviews, we quantified the variables related to forest experiences, psychological variables and additional variables to describe the sampled population. Prior to data collection, we tested the protocol with 16 people from the study region but living in properties outside the study landscapes, to adjust the language and response format.

2.4.2 | Forest experiences

The three variables – direct contact with forest and received ecosystem services and disservices – were measured as frequencies. To quantify direct contact with forests, we considered the number of days the individual went to the forest in the month prior to the interview, even if for a short visit. To quantify the frequency of receiving ecosystem services and disservices, we considered the last 6 months prior to the interview and adopted a visual unipolar scale with seven categories (1-never to 7-always, Data S2). Both variables were multi-item indices, describing either the types of benefits (services) or harm/disadvantages (disservices) received from forests. These items were based on the salient behavioural beliefs (elicited in the studied population, see below; Data S2). For the index of receiving ecosystem services, items included both direct consumptive (e.g. using water form forest springs) and non-consumptive (e.g. having fun in the forest) uses, excluding indirect uses (e.g. have cleaner water or air) and non-use benefits (e.g. be pleased to know that plants and animals exist) for which frequency is hard to quantify. For the index of receiving ecosystem disservices, items included all types of harms/disadvantages associated with the salient beliefs. To calculate the indices of frequency of receiving ecosystem services and disservices, we summed the values across the 11 and six items respectively.

2.4.3 | Beliefs, attitude and intention

To measure behavioural beliefs, attitude and intention, the behaviour under investigation should be clearly defined (Fishbein & Ajzen, 2010). From pilot interviews to identify the actions people commonly do to preserve forests and how they refer to forest preservation in daily language, we defined the behaviour of interest as: '*Taking care of the forest in the property for the next five years*' (Data S2). The action of 'taking care of the forest' was explained to participants as encompassing one or more of the following specific behaviours: (a) fencing or guarding the forest, (b) removing garbage from the forest and avoiding (c) the use of fire to clear the land, (d) the construction of forest trails or roads or (e) clearings and thinning the forest (Data S2). Therefore, the behaviour of interest relates to actively maintaining forest integrity, comprising more than keeping forest within the property, as required by the Brazilian Forest Code that regulates the protection of native vegetation in private lands (Federal Law 12.727, 2012; Soares-Filho et al., 2014).

Behavioural beliefs are related to perceived behavioural outcomes (e.g. taking care of the forest provides us with a better climate) and should be elicited from the population of interest to account for the actual local salient beliefs (Fishbein & Ajzen, 2010), which we did during a pilot study (Data S2). The index of behavioural beliefs then included 17 items associated with benefits, and six items associated with harms/disadvantages of performing the behaviour of interest. Following Pascual et al. (2010), items related to benefits were a posteriori divided into those associated with consumptive direct uses, non-consumptive direct uses, indirect uses and non-use benefits (Data S2). Using the expectancy–value model (Fishbein & Ajzen, 2010), the behavioural belief index was calculated as the sum of the product between the strength (i.e. the subjective probability of that specific outcome – belief – resulting from the behaviour) and the evaluation (i.e. how essential or severe the individual considers that specific outcome to be) across all 23 items (i.e. salient beliefs). The product of the six salient beliefs associated with harms/disadvantages was multiplied by −1, so that its contribution to the belief index was negative. Participants responded to items concerning belief strength and evaluation by choosing between seven categories of a visual unipolar scale (Data S2).

We measured attitude with a traditional semantic differential scale (Osgood, Suci, & Tannenbaum, 1978) composed of six pairs of adjectives (i.e. six items). Three adjectives were related to an instrumental aspect, while three to an experiential aspect, of the behaviour 'taking care of forest'. For each of these six items (e.g. how useless/useful do you think it is to take care of the forest), participants responded using a visual bipolar scale with seven categories (−3 to +3), and we summed up the values across the six items (Data S2).

To measure intention, we used a Likert scale composed of eight items, each corresponding to a sentence expressing motivational states (e.g. you want to take care of the forest) – four sentences in favour and four in disfavour of performing the behaviour of interest. Participants gave their level of agreement to each item using a visual unipolar scale with seven categories, and the intention scale was calculated as the sum across all eight items (Data S2).

2.4.4 | Additional variables

To characterize the population, we asked participants their sex, age and schooling level (number of completed school years). We also asked them: the context (rural, urban or both) (a) where the current productive activity is conducted (e.g. in their own properties or in the city), (b) where they spent their childhood (until 10 years old), and (c) if they owned a list of 24 assets, which was then used to estimate and index of asset-based wealth (details in Data S2).

2.4.5 | Interviewing

Interviews were conducted by two researchers from March to August 2017. Both were present during the first 30 interviews to standardize their way of talking and acting. At the interview onset, a folder containing the project idea and contact information was delivered to all interviewees, and informed consent to participate in the study was obtained from all of them. The protocol was approved by the Research Ethics Committee from the Brazilian National Commission for Research Ethics (*CAAE nº 61720916.0.0000.5464 in Plataforma Brasil*).

2.5 | Data analysis

2.5.1 | Scale evaluation

In psychometrics, scale items are developed to measure the same underlying construct, and a high inter-item correlation is expected (Widhiarso & Ravand, 2014). We used three analyses to test the reliability and validity of the scales for measuring attitude and intention of taking care of forest, and all of them indicated the scales were reliable and measured a single construct (Data S3). In contrast, there is no need to evaluate indices (such as those regarding behavioural beliefs, and frequency of receiving ecosystem services and disservices) because their items were not meant to measure the same construct (Bollen & Bauldry, 2011).

2.5.2 | Testing the conceptual model

To test the conceptual model (Figure 1), we used Piecewise Structural Equation Modeling (Piecewise-SEM; Lefcheck, 2016a) implemented using *piecewiseSEM* package in R (Lefcheck, 2016b). Compared to traditional SEM, Piecewise-SEM requires smaller sample size, does not assume a multinormal distribution and allows the use of mixed-effects models (Lefcheck, 2016a; Shipley, 2013).

We tested for the best distribution and link function to model each response variable and for collinearity among independent variables (Data S3). To control for the spatial dependence (related to the hierarchical sampling design) and temporal dependence in the dataset we used mixed-effects models, considering the study landscapes and the month when interviews were conducted (March–August) as random variables.

In Piecewise-SEM, comparison of the data to the model is made using an alternative to chi-square test for goodness-of-fit, the Fisher's C statistic (Lefcheck, 2016a). If the corresponding p-value is above 0.05, the data support the model, and the significance of the different paths in the model can be evaluated. We run four versions of the conceptual model (Figure 1), containing the same conceptual variables and pathways, differing only in the spatial scale at which forest cover was measured to represent the ecological context people live in (see Data Collection). We assessed the fit of the four versions of the conceptual model using Fisher's C statistics, and compared them through Akaike's Information Criterion corrected for small samples (AICc). We considered that $\Delta AIC \le 2$ indicates equally plausible models, but that models have no empirical support only when $\Delta AIC > 10$ (Burnham & Anderson, 2002). We then identified the relevant pathways within the model versions with good fit to the data using the pathways p-values (detailed summary statistics for all model versions, in Table 1).

3 | RESULTS

The size of rural properties owned by participants varied considerably (2–309 ha), although most (52%) were smaller than 20 ha. Area of native forest within properties also varied substantially (1–193 ha), with most (59%) smaller than 5 ha. Most participants were men (75%) and age ranged from 23 to 82 years, but 44% of interviewees were older than 60 years old. Most participants had a TV and a cell phone (98% and 94%, respectively), while a lower proportion owned a car (79%) or a tractor (44%). Schooling level was low to medium, with 51% having completed less than 5 years of study. Most participants were raised in rural areas (74%) and spent their working hours in farming activities (79%).

Number of visits to forest in the previous month averaged 2.75, with 42% of participants having visited forests at least once (Data S4). On average, participants received ecosystem services far more frequently than ecosystem disservices (Data S4; Figure 3). Participants had, on average, positive beliefs, attitude and intention of taking care of forests within their properties (Data S4). Richer people, and those with more years of school education, had stronger intention of preserving forest, while there was no association of intention of preserving forests with sex, age, context of the main activity or context of the childhood (Data S4).

For both belief strength and evaluation, responses varied strongly across items. Among belief items indicating benefits from forests, those associated with non-consumptive uses (e.g. appreciating plants and animals), indirect uses (e.g. climate regulation) and non-use benefits (e.g. legacy gratification) were perceived as more likely and essential, having the highest correlation with attitude (from 0.35 to 0.66, Figure 3a,b). Among belief items associated with consumptive uses, water was the most important (Figure 3a,b). In contrast, belief items indicating harms/disadvantages resulting from preserving forests were perceived as quite unlikely, with wildlife attacks being considered the worst (Figure 3a,b). Beliefs related to benefits were more strongly correlated to attitude towards preserving forest (mean ± SD: 0.37 ± 0.18) than beliefs related to harms/disadvantages (mean ± SD: 0.30 ± 0.06, Figure 3b). Finally, what participants believed were the outcomes of preserving forest remnants (i.e. beliefs) was congruent with what they experienced (i.e. frequency of receiving ecosystem services and disservices; Figure 3c,d).

3.1 | Conceptual model

The conceptual model on the pathways through which the ecological context influences beliefs, attitude and intention of preserving forest remnants (Figure 1) presented good fit to the data, when considering three of the four spatial scales at which we measured the ecological context ($C > 29$, $df = 24$, $p > .23$, Table 1). For these three versions of the model (ecological context measured at 0.5, 1.0 and 1.5 km around participants' houses), standard errors of estimated coefficients were small, indicating enough sample size, and AICc values were similar (Table 1). However, the significant pathways linking the ecological context and the intention of preserving forest remnants differed depending on the spatial scale the ecological context was measured (Figure 4). The link between ecological context and direct contact with forests was significant and positive only when considering the immediate ecological context (0.5 km). Similarly, the link between ecological context and frequency of receiving ecosystem services was significant and positive only when considering the ecological context at larger spatial scale (1.5 km). In contrast, the links between (a) direct contact with forest and frequency of receiving ecosystem services, (b) frequency of receiving ecosystem services and behavioural beliefs, (c) behavioural

TABLE 1 Piecewise-SEM results for the four versions of the conceptual model (Figure 1) on the pathways through which the ecological context rural people live in influences beliefs, attitude and intention of preserving forest remnants within their properties

Scale of the ecological context[a]	Fisher's C	*df*[b]	*p*-value[c]	AICc[d]	*K*[e]	Significant path coefficients (*SE*) – *p*-values								
						EC-DC	EC-ES	EC-ED	DC-ES	DC-ED	ES-B	ED-B	B-A	A-I
0.5	26.48	24	0.329	119.412	32	**3.166 (0.543) <0.001**	4.516 (7.197) 0.543	−0.024 (0.472) 0.959	**0.517 (0.140) <0.001**	−0.002 (0.009) 0.869	**0.012 (0.003) <0.001**	0.102 (0.213) 0.632	**0.001 (<0.001) <0.001**	**0.084 (0.013) <0.001**
1.0	27.62	24	0.277	120.552	32	1.467 (0.756) 0.052	10.013 (8.895) 0.287	0.208 (0.623) 0.739	**0.524 (0.139) <0.001**	−0.002 (0.009) 0.844	**0.012 (0.003) <0.001**	0.102 (0.213) 0.632	**0.001 (<0.001) <0.001**	**0.084 (0.013) <0.001**
1.5	28.6	24	0.236	121.532	32	−0.248 (0.928) 0.789	**22.982 (8.392) 0.013**	0.069 (0.629) 0.913	**0.533 (0.135) <0.001**	−0.002 (0.009) 0.860	**0.012 (0.003) <0.001**	0.102 (0.213) 0.632	**0.001 (<0.001) <0.001**	**0.084 (0.013) <0.001**
2.0	53.58	24	<0.001	146.512	32	—	—	—	—	—	—	—	—	—

Note: Model versions differ only in the scale at which forest cover was measured to represent the ecological context people live in. Coefficients (with standard error) and *p*-values (significant in bold) for each of the paths are shown only for the model versions that fitted the data.

Abbreviations: A, attitude; B, beliefs; DC, direct contact with forest; EC, ecological context; ED, frequency of receiving ecosystem disservices; ES, frequency of receiving ecosystem services; I, intention of preserving forest.

[a]Radius (in km) of the buffer around participants' household used to measure forest cover.

[b]Degrees of freedom.

[c]*p* > .05 indicates a good fit.

[d]Akaike's Information Criterion corrected for small samples.

[e]Number of parameters.

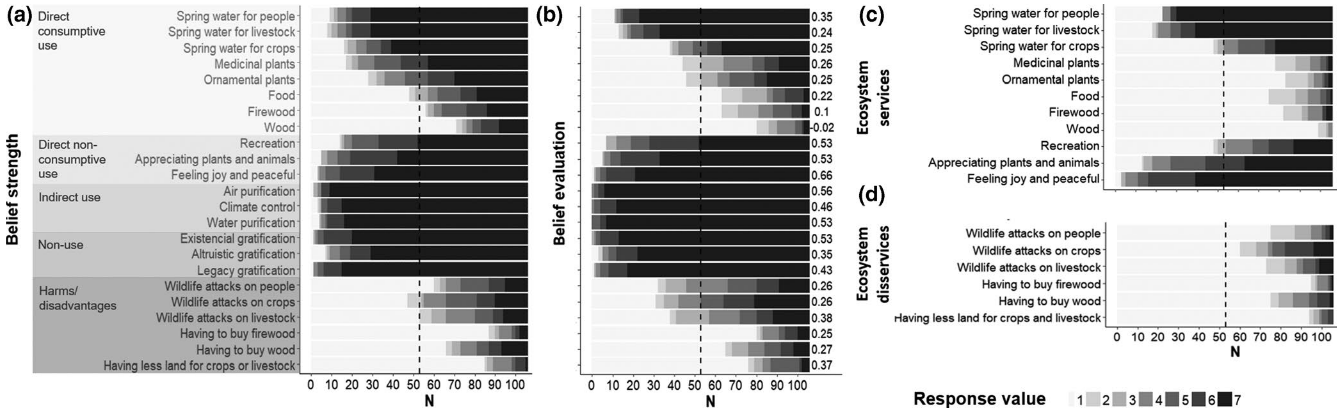

FIGURE 3 Responses of the 106 participants to the items of the indices for measuring beliefs towards preserving forest remnants, and frequency of receiving ecosystem services and disservices. Responses were measured with a seven-category visual unipolar scale. (a) Belief strength – measures outcome probability (1-*no way* to 7-*surely*). Non-use beliefs represent different types of personal gratification (for knowing that nature exists and that it can be enjoyed by others or by future generations). The last three beliefs associated with disadvantages are related to restrictions in the use of firewood, wood or land caused by forest preservation. (b) Belief evaluation – measures how essential (for benefits) or severe (for harms/disadvantages) the outcome is (1-*nothing* to 7-*very*). The values at the right indicate the correlation of each belief (the product of the strength and evaluation) and the attitude scale. (c) Frequency of receiving ecosystem services (1-*never* to 7-*always*). (d) Frequency of receiving ecosystem disservice (1-*never* to 7-*always*). Dashed vertical line – half of the participants (N = 53)

beliefs and attitude, and (d) attitude and intention were significant and positive in the three versions of the model, irrespective of the spatial scale (0.5, 1.0 and 1.5 km) of the ecological context (Figure 4).

4 | DISCUSSION

Our results highlight the relevance of the ecological context, via forest experiences – and particularly via ecosystem services – for shaping landowners' beliefs, attitude and intention of preserving forest remnants within their private properties. To our knowledge, these results are novel in two fronts. They expand the findings of previous studies conducted in urban contexts (Soga et al., 2016; Wells & Lekies, 2006; Zaradic et al., 2009) to suggest that, beyond urbanization, deforestation in rural areas of the tropics may also lead to the extinction of experiences with nature and to weak intention of preserving forests. Our findings also highlight the relevance of taking into account psychological attributes, linked to individual beliefs, attitudes and behaviour, as central aspects to conservation in tropical regions (Rueda et al., 2019). In the following paragraphs, we first discuss which background factors (contact with forests, and received ecosystem services and disservices)

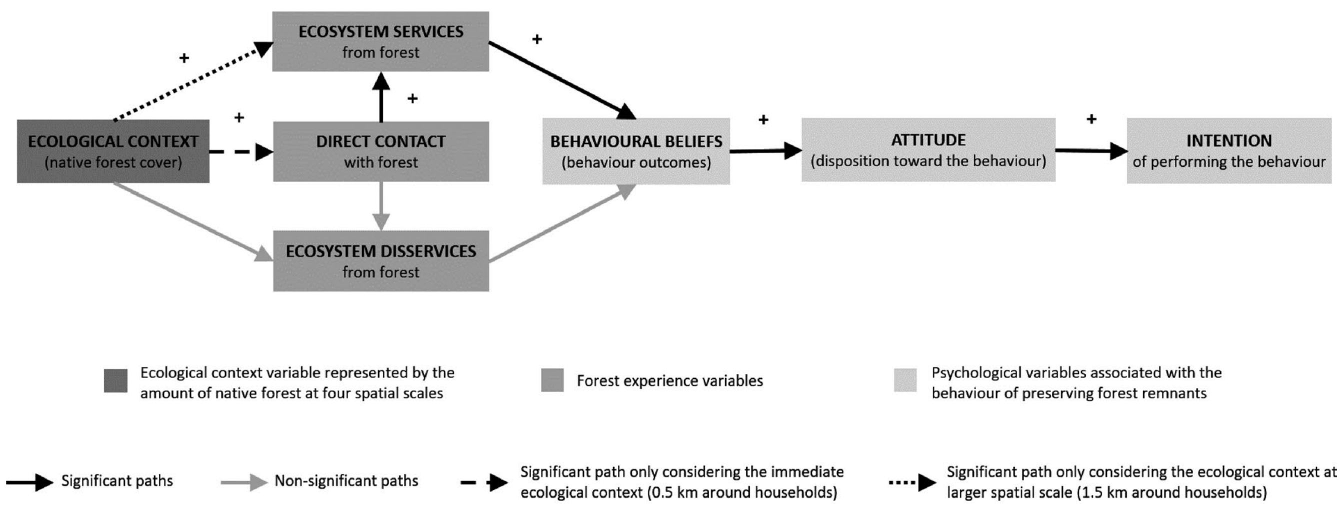

FIGURE 4 Significant pathways through which the ecological context people live in influences beliefs, attitude and intention of preserving forest remnants within private properties. Significant pathways result from testing the conceptual model in Figure 1 using Piecewise Structural Equation Modelling. We tested four versions of the conceptual model, varying only in the spatial scale at which we measured the ecological context (native forest cover at 0.5, 1.0, 1.5 and 2.0 km radius around participants' households). Summary statistics for each of the four model versions, including coefficient estimates (with their errors and p-values), are presented in Table 1

shape the intention of preserving forests. We then focus on how these forest experiences are influenced by the ecological context people live. We end up by discussing five implications of our results to forest conservation in private lands.

4.1 | Which forest experiences shape intention of preserving forest remnants?

Although not always recognized or emphasized, experiences of nature can be either positive or negative (Clayton et al., 2017). Indeed, the same ecosystem can bring both services (benefits) and disservices (harms/disadvantages) because humans assign different values to system properties – either attributes or functions – determining the relative importance of services and disservices (Vaz et al., 2017). Our results suggest that ecosystem services can be far more important than disservices for shaping the attitude and intention of preserving forests among landowners in rural areas of the tropics. Four lines of evidence support this statement. First, receiving ecosystem services, unlike receiving ecosystem disservices, significantly (and positively) affected beliefs on the outcomes of preserving forest remnants. Second, people reported higher frequencies of receiving ecosystem services than disservices. Third, the number of salient beliefs associated with benefits provided by forests was much higher than those associated with harms/disadvantages suffered from forests. Lastly, most items related to positive beliefs were ranked higher, and were more correlated with attitude towards preserving forest remnants than those related to negative beliefs.

Although there is growing evidence that an ecological system can be simultaneously perceived as advantageous and disadvantageous (Ango, Börjeson, Senbeta, & Hylander, 2014; Rasmussen et al., 2017), few studies have explored how the balance between these perceptions influence the determinants of behaviours towards nature conservation, as we did. The perceived balance between services and disservices was shown to be important in determining tree management practices in agriculture landscapes in Ethiopia (Ango et al., 2014). Similarly to what we observed, Dorresteijn and collaborators (2017) also found people valued services more than disservices in rural Ethiopia, where people were more dependent on forest products and suffered a higher intensity of disservices than in our study region. However, they did not observe, as we did, that this balance between perceived advantages and disadvantages influenced the attitude towards forests. Hence, our results not only corroborate that ecosystem services are more valued than disservices in rural areas of the tropics, but also show that they may be a key driver of attitude and intention towards conservation in these settings.

Besides the importance of ecosystem services compared to disservices in shaping beliefs, attitude and intention of preserving forest, we found that, across different ecosystem services, those related to non-provisioning benefits are of foremost importance. Landowners believed that the outcomes of preserving forests related to direct non-consumptive uses (e.g. enjoying plants and animals), indirect uses (e.g. air purification) as well as non-use benefits (e.g. legacy gratification) were more likely and essential than outcomes related to most provisioning services (e.g. medicinal plants or food from the forest). Moreover, they considered having received these services more frequently than most provisioning services. This corroborates other studies, from varied tropical areas and contexts, showing that people value forests for their non-provisioning benefits (Dorresteijn et al., 2017; Torres, Morsello, Parry, & Pardini, 2016).

Consumptive uses related to provisioning services, however, are usually very important to people's subsistence in the tropics, especially wood fuels and bushmeat (Angelsen et al., 2014). The observed low relevance of provisioning services such as firewood and bushmeat is probably associated with certain characteristics of our study area, located in a consolidated region nearby small and large urban centres, where these resources are currently rare (e.g. bushmeat) and/or people can easily purchase substitutes (e.g. gas stove, marketed meat). In contrast, the most important provisioning service – both in terms of beliefs towards preserving forests and frequency of receiving – was water for human and livestock consumption. The high perceived value of water, in turn, may be related to the fact that our study region harbours one of the largest water reservoir system in the world and has suffered from recurrent hydric crisis during the last decades (Coutinho, Kraenkel, & Prado, 2015; Whately & Cunha, 2007). This highlights how variable local demands for ecosystem services can be across the tropics.

Among disservices, those perceived as most severe were related to the attacks from wildlife on crops and livestock, as observed elsewhere (Dorresteijn et al., 2017). However, even those were perceived as relatively unlikely and irrelevant, and happening at low frequencies, compared to certain ecosystem services (e.g. feeling joy and peaceful by being in the forest or observing the forest). This is not surprising considering that native fauna is relatively impoverished in Atlantic Forest remnants (Galetti et al., 2009). Yet, it is important to highlight that attacks from wildlife may affect tolerance towards wildlife even though they did not affect the intention of preserving forests, as we observed in our study region (Teixeira, 2018). On the other hand, ecosystem disservices more closely linked to the idea that preserving forest may restrict economic opportunities – in particular, having less land for crops and livestock – were considered irrelevant by participants. These disservices may be more severe in poorer regions of the tropics, in deforestation frontiers or in regions where fewer economic options are available, compared to consolidated areas nearby large urban centres, such as our study region. In Brazil, in particular, these disservices may also be more significant in regions, such as the Amazon, where the area of forest legally required to be maintained within private properties is larger than in the Atlantic forest, thus reducing the land within each property available for agriculture production.

The salient beliefs on the outcome of preserving forests elicited in the study population corresponded to ecosystem services and disservices, and these beliefs influenced attitude and intention of preserving forests. Thus, ecosystem services and disservices can indeed be understood as experiences of forest, affecting how people value forests (Clayton et al., 2017). In contrast, we assumed that direct contact with forests (i.e. visits to forest for whatever reason) indirectly affects beliefs, attitudes and intention of preserving forests, by affecting the frequency of receiving ecosystem services and disservices. For instance, people that visits forest more often for taking care of the system for collecting water from springs – the main reason for visiting forests in our study landscapes – may have higher chances of receiving certain ecosystem services (e.g. enjoying forest plants and animals) or disservices (e.g. being attacked by a venomous animal). We observed, however, that direct contact with forest was associated only with the frequency of receiving ecosystem services, but not disservices. This is probably related to the fact that some of the most valued ecosystem services in the study landscapes either require visiting forests (i.e. having fun in the forest) or can also happen when visiting forests (i.e. enjoying forest plants and animals, feeling joy and peaceful by being in the forest or observing the forest). In contrast, not only ecosystem disservices was less important to landowners than services (as discussed above), but also the most relevant disservices (i.e. attacks to crops and livestock) does not depend on being physically present in the forest to be experienced.

4.2 | How does the ecological context influence different types of forest experiences and the intention to preserve forests?

Our results show the ecological context people live in, represented by the amount of remaining forest at the landscape, positively influences both direct contact with forest and the frequency of receiving ecosystem services, ultimately affecting the intention of preserving forests. These effects, however, depended on the spatial scale at which we measured forest cover. Hence, similar to the relevance of considering landscape characteristics at different spatial scales in biodiversity studies (e.g. Gonthier et al., 2014), our results highlight the importance of multi-scale assessments of the ecological context in studies focusing on nature experiences and human behaviour.

At smaller scales, we observed a significant positive effect of the ecological context on direct contact with forest. Given that we estimated direct contact as the number of forest visits, it is not surprising that people who visit forests more frequently are those inhabiting houses immediately surrounded by a higher amount of forest. In contrast, the positive effect on the frequency of receiving ecosystem services was significant only at larger spatial scales. Again, this is expected given the variety of services we measured, some of which depend on the maintenance of forest at broad spatial scales (e.g. hydrological cycle regulation; Shvidenko et al., 2005). As those broad scales exceed the size of most local properties, several ecosystem services depend on conserving forests in neighboring properties, as observed elsewhere (Dorresteijn et al., 2017), indicating the relevance of coordinated conservation efforts among individuals (Zhang, Ricketts, Kremen, Carney & Swinton, 2007).

Several studies discuss the importance of social, political and economic contexts to human ecosystems valuation processes (Shackleton et al., 2016; Vaz et al., 2017). Fewer studies consider the role of the environmental–ecological context (e.g. altitude, forest and resource proximity) on the perceptions of ecosystem services and disservices (Ango et al., 2014; Rasmussen et al., 2017); yet, they do not link these experiences to attitude or intention towards nature (but see Dorresteijn et al., 2017). Hence, our results are novel, and expand the findings concerning urbanization, which suggest the ecological context – urban versus rural (e.g. Collado et al., 2015; Zhang et al., 2014) or the amount of tree cover in cities (Shanahan et al., 2017) – influence the willingness to conserve, pro-environmental behaviours and/or human–nature connections. Therefore, as urbanization, deforestation in rural areas in tropical regions may reduce forest experiences, ultimately impairing conservation behaviours.

Our results suggest the possibility of a dangerous positive feedback loop between deforestation and the extinction of human–nature connections, particularly via decreasing the frequency of receiving and the valuation of ecosystem services, leading to lower intention of preserving forests and potentially to further deforestation. This idea has been previously proposed in general terms (Pyle, 2003; Soga & Gaston, 2016). Yet to directly test the potential of such feedback loops, we need long-term longitudinal studies evaluating how patterns of receiving ecosystem service, beliefs, attitude and intention towards nature change throughout the lifespan (i.e. intragenerational), and how they are transmitted across generations (i.e. intergenerational; Grønhøj & Thøgersen, 2009).

We should also highlight that, although the effect of the ecological context on the intention of preserving forest was significant and positive, people still had, on average, neutral to positive beliefs, attitude and intention of preserving forest even in the most deforested contexts. It is also important to note that the context people live in, and their nature experiences (i.e. forest experiences), are some of the factors affecting conservation support (i.e. the intention of preserving forest), via their effects on behavioural beliefs and attitude. Other factors, such as education and economic status may also be relevant (e.g. Dean et al., 2019; Sato et al., 2017). Indeed, schooling level and wealth were positively associated with the intention of preserving forests in this study. These, as well as other social or economic background factors, however, probably affect the intention of preserving forests via alternative pathways associated with the two psychological constructs (beyond attitude) expected to affect intention in the Reasoned Action Approach (Fishbein & Ajzen, 2010). These are the subjective social norms that are expected to be linked to cultural and sociodemographic background factors, and the perceived behavioural control that are expected be linked to economic background factors (among others, as available time or skills). However, it should be noted that social norms may be less relevant to define intention where communities in the strict sense – common location, small size and homogeneous composition/shared characteristics – are not the rule (e.g. Rueda et al., 2019), as in the case of our study region. Similarly, the effects of perceived behavioural control may be stronger in poorer areas than our study region, given that one of the aspects affecting this psychological construct is having the economic resources to execute the behaviour of interest.

Finally, the observed effects of the ecological context on the intention of preserving forests open new intriguing research questions. For instance, whether there are thresholds in beliefs, attitude and intention towards nature conservation as the loss of native vegetation progresses, alike those found for ecological communities (Banks-Leite et al., 2014). If these psychological thresholds do exist, whether they occur at the same amount of remaing habitat as ecological thresholds. Finally, whether the feedback between forest cover and intention of preserving forest is strong enough to lead to alternative stable states and critical transitions in rural landscapes (sensus Scheffer, 2009). These questions have the potential to tighten the bonds between Ecology and Social sciences in achieving conservation goals.

4.3 | Implications for conservation

First, our results suggest the key role that using natural resources, and receiving non-use benefits provided by ecosystems, have to the success of conservation initiatives. Until the eighties, conservation biology was focused on isolating humans from nature through the implementation of restricted-use protected areas (Mace, 2014), frequently leading to the displacement of local communities and social conflicts (Agrawal & Redford, 2009). Restricted-use protected areas are still a common biodiversity conservation strategy, which is undoubtedly crucial, albeit not sufficient (Kamal, Grodzińska-Jurczak, & Brown, 2015). Particularly in private lands, a positive intention towards nature is the key to the success of the variety of nature conservation policy options, from involuntary (e.g. compliance to top–down government regulations) to voluntary approaches (e.g. bottom-up strategies depending on the proactive decision of landowners' to engage; Kamal et al., 2015). Receiving ecosystem services is a key experience determining how people value forests and should be considered to improve the success of conservation efforts in consolidated areas of the tropics.

Second, conservation initiatives should incorporate the perceptions of local people regarding both ecosystem services and disservices. Ecosystem service approach to conservation has grown considerably and effort has been put to identify and map ecosystem services at large scales (e.g. Li & Fang, 2014). Nevertheless, the approach often disregards ecosystem disservices and the trade-offs between services and disservices (Small, Munday, & Durance, 2017). Moreover, the perception of services and disservices varies across contexts (Shackleton et al., 2016; Vaz et al., 2017; Zhang et al., 2007). Hence, beyond mapping service provision at large scales, local initiatives incorporating ecosystem service demands, determined by people perception and valuation, is crucial to increase the chances of engaging local people into conservation actions. For instance, in our study region, conservation initiatives focusing on water provision are more likely to promote voluntary actions from landowners to preserve forest remnants.

Third, accounting for all types of ecosystems services, including both use and non-use benefits, is critical. Ecosystems provide a variety of services, often creating trade-offs for different stakeholders. Thus, to be comprehensive, conservation initiatives should incorporate less tangible benefits (Daniel et al., 2012). Often, the most valued ecosystem services lack market values, as occurs with non-consumptive uses (also known as cultural services), indirect services and to non-use benefits, making them more difficult to monetize (Pascual et al., 2010; Small et al., 2017). Hence, developing techniques to account for ecosystem services related to indirect uses, recreation or spiritual uses (e.g. Daniel et al., 2012), among others, is of foremost importance.

Fourth, it is essential to incorporate the ecological context when planning environmental policies and management in rural areas of the tropics (see also Torres et al., 2016). In forested landscapes, where people receive ecosystem services frequently, initiatives focusing on sustainable use of resources linked to certain provisioning services, as well as on services linked to non-use benefits, are more likely to succeed, as they may help to maintain the feedback between using, valuing and preserving forests. In contrast, in areas where native forest cover has been largely reduced, human–nature connections tend to be impaired, because people tend to interact less with forest, receive ecosystem services less frequently and value less the forest. As such, in these deforested landscapes, conservation strategies should first focus on initiatives to counteract the extinction of forest experiences and increase the perceived value of forests. Although many such strategies exist, such as outdoor education programmes (Braun & Dierkes, 2017) and nature camps (Collado, Staats, & Corraliza, 2013), they were developed mostly for children or youth in urban contexts. Developing similar strategies adapted to the context of rural landowners in the tropics is thus of foremost importance.

Lastly, although economic and sociodemographic factors are certainly relevant, our findings show that at least in consolidated rural areas of the tropics, individual intention of landowners to preserve their forest is also shaped by the ecosystem services they receive, which in turn depend on the ecological context beyond their property limits. Thus, coordinated conservation efforts are required and these depend on cross-boundary cooperation (Rickenbach, Schulte, Kittredge, Labich, & Shinneman, 2011), which may be particularly difficult to implement in rural areas characterized by land and resources managed in de facto private regimes. Considering diverse forest conservation strategies (listed in Kamal et al., 2015) and hybrid environmental governance arrangements (proposed in Armitage et al., 2012) is then crucial in these culturally and economically heterogeneous private lands.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

AUTHORS' CONTRIBUTIONS

K.C.T.-D. and R.P. conceived the research and methodology, with input from L.T., E.C. and C.M. Data were collected by K.C.T.-D. and L.T. and analysed by K.C.T.-D. and G.d.L.M. K.C.T.-D. and R.P. wrote the manuscript incorporating suggestions from E.C. and C.M. All authors gave final approval for publication.

DATA AVAILABILITY STATEMENT

Data corresponding to all variables, indices and scales obtained through face-to-face interviews with the 106 landowners and used to test the conceptual model are publicly available at the Figshare repository – https://doi.org/10.6084/m9.figshare.9637124.v1 (Tisovec-Dufner et al., 2019).

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